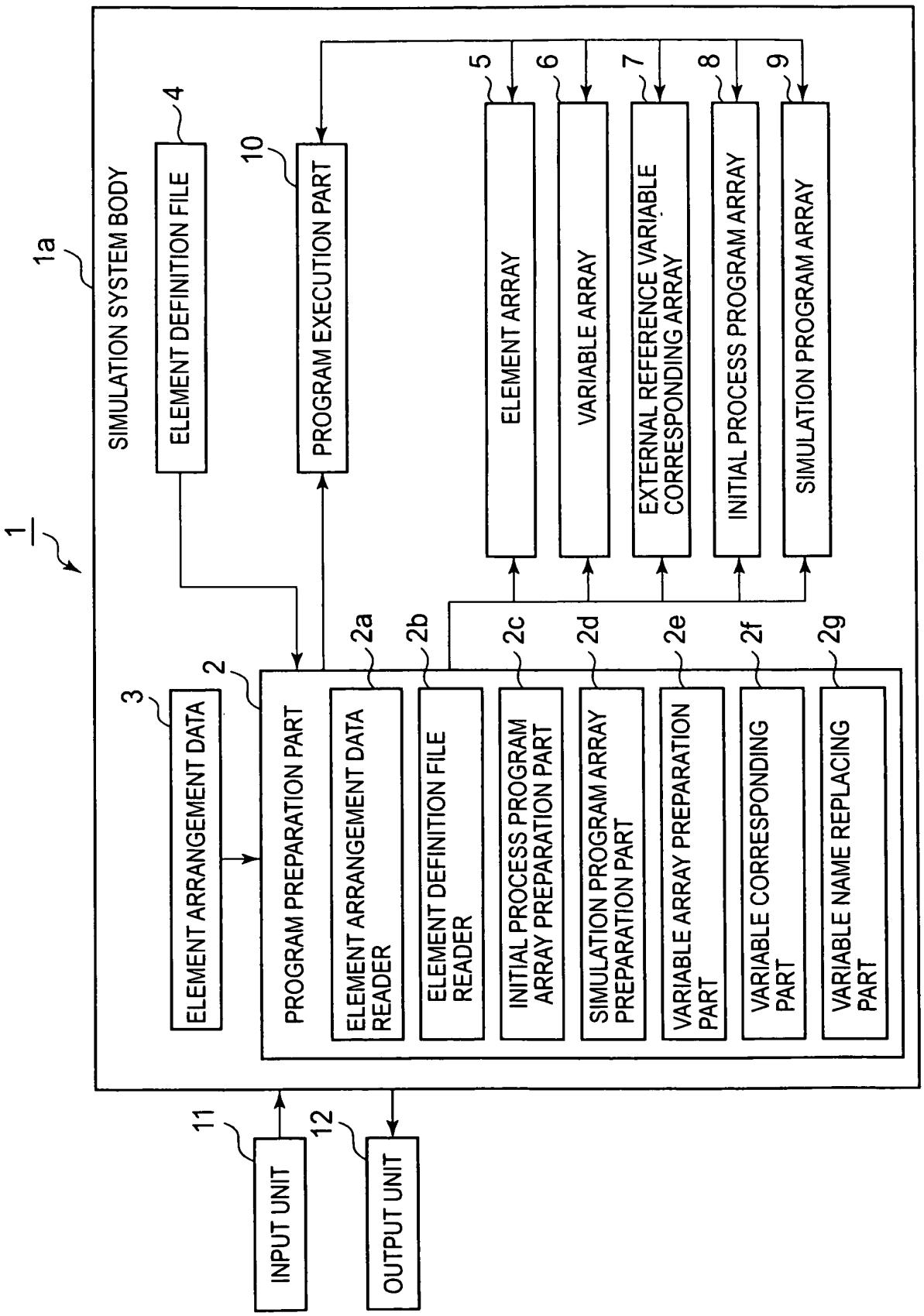
1
1a
SIMULATION SYSTEM BODY
ELEMENT DEFINITION FILE
4
PROGRAM EXECUTION PART
10
ELEMENT ARRAY
5
VARIABLE ARRAY
6
EXTERNAL REFERENCE VARIABLE CORRESPONDING ARRAY
7
INITIAL PROCESS PROGRAM ARRAY
8
SIMULATION PROGRAM ARRAY
9
ELEMENT ARRANGEMENT DATA
3
PROGRAM PREPARATION PART
2
ELEMENT ARRANGEMENT DATA READER
2a
ELEMENT DEFINITION FILE READER
2b
INITIAL PROCESS PROGRAM ARRAY PREPARATION PART
2c
SIMULATION PROGRAM ARRAY PREPARATION PART
2d
VARIABLE ARRAY PREPARATION PART
2e
VARIABLE CORRESPONDING PART
2f
VARIABLE NAME REPLACING PART
2g
INPUT UNIT
11
OUTPUT UNIT
12

FIG. 1

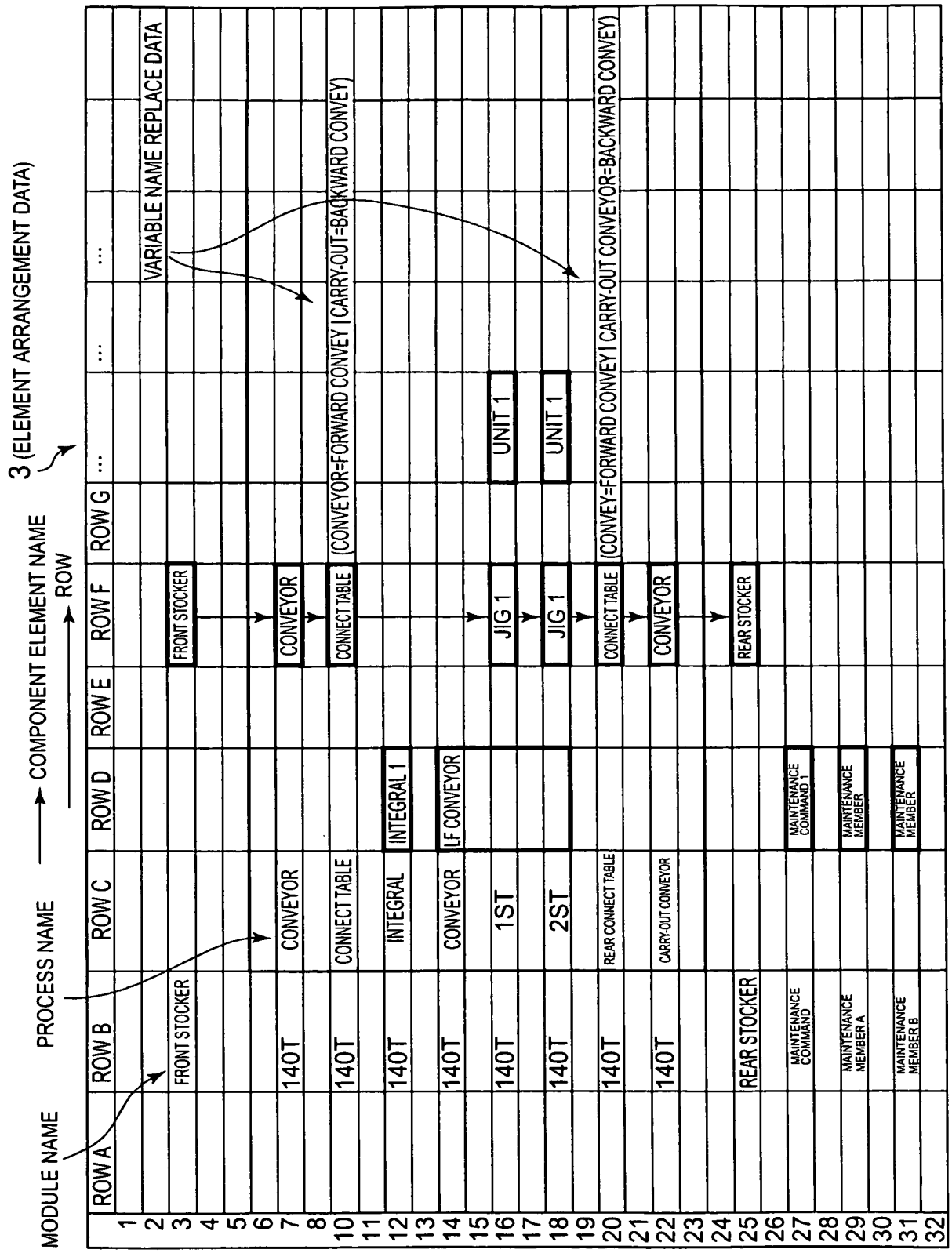
MODULE NAME
PROCESS NAME
COMPONENT ELEMENT NAME
ROW
3 (ELEMENT ARRANGEMENT DATA)
LINE
ROW A
ROW B
ROW C
ROW D
ROW E
ROW F
ROW G
...
...
...
VARIABLE NAME REPLACE DATA
FRONT STOCKER
FRONT STOCKER
CONVEYOR
140T
CONVEYOR
CONNECT TABLE
140T
(CONVEYOR=FORWARD CONVEY | CARRY-OUT=BACKWARD CONVEY)
INTEGRAL
INTEGRAL 1
140T
CONVEYOR
LF CONVEYOR
140T
1ST
JIG 1
UNIT 1
140T
2ST
JIG 1
UNIT 1
140T
REAR CONNECT TABLE
CONNECT TABLE
(CONVEY=FORWARD CONVEY | CARRY-OUT CONVEYOR=BACKWARD CONVEY)
140T
CARRY-OUT CONVEYOR
CONVEYOR
REAR STOCKER
REAR STOCKER
MAINTENANCE COMMAND
MAINTENANCE COMMAND 1
MAINTENANCE MEMBER A
MAINTENANCE MEMBER
MAINTENANCE MEMBER B
MAINTENANCE MEMBER

FIG. 2

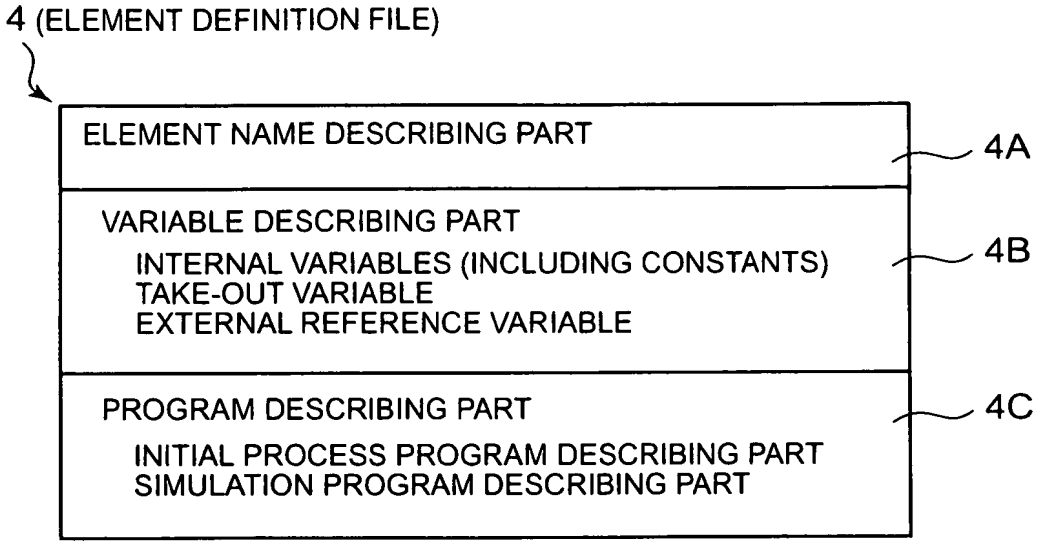
4 (ELEMENT DEFINITION FILE)
ELEMENT NAME DESCRIBING PART
4A
VARIABLE DESCRIBING PART
INTERNAL VARIABLES (INCLUDING CONSTANTS)
TAKE-OUT VARIABLE
EXTERNAL REFERENCE VARIABLE
4B
PROGRAM DESCRIBING PART
INITIAL PROCESS PROGRAM DESCRIBING PART
SIMULATION PROGRAM DESCRIBING PART
4C

FIG. 3

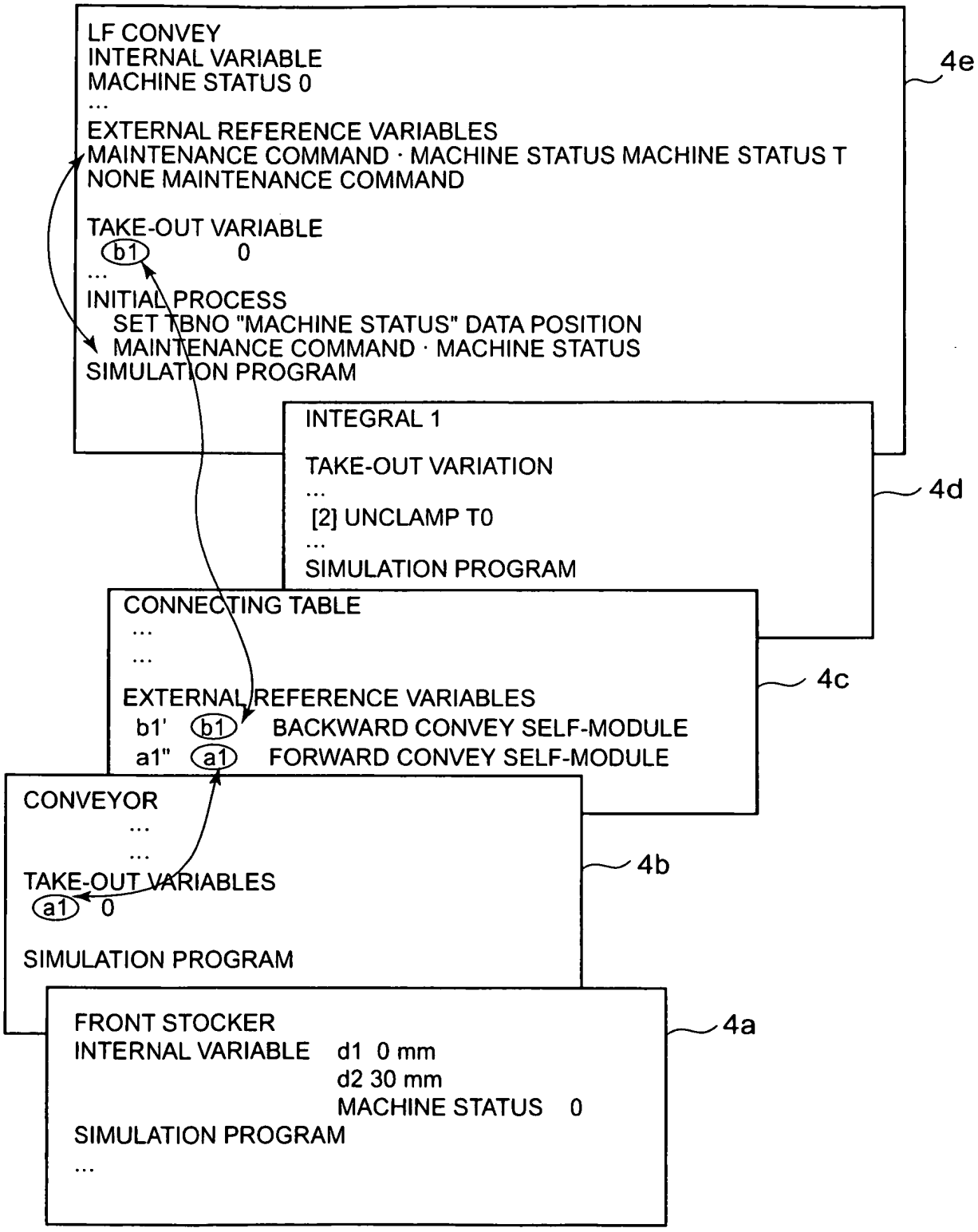
LF CONVEY
INTERNAL VARIABLE
MACHINE STATUS 0
...
EXTERNAL REFERENCE VARIABLES
MAINTENANCE COMMAND · MACHINE STATUS MACHINE STATUS T
NONE MAINTENANCE COMMAND
TAKE-OUT VARIABLE
b1 0
...
INITIAL PROCESS
SET TBNO "MACHINE STATUS" DATA POSITION
MAINTENANCE COMMAND · MACHINE STATUS
SIMULATION PROGRAM
4e
INTEGRAL 1
TAKE-OUT VARIATION
...
[2] UNCLAMP T0
...
SIMULATION PROGRAM
4d
CONNECTING TABLE
...
...
EXTERNAL REFERENCE VARIABLES
b1' b1 BACKWARD CONVEY SELF-MODULE
a1" a1 FORWARD CONVEY SELF-MODULE
4c
CONVEYOR
...
...
TAKE-OUT VARIABLES
a1 0
SIMULATION PROGRAM
4b
FRONT STOCKER
INTERNAL VARIABLE d1 0 mm
d2 30 mm
MACHINE STATUS 0
SIMULATION PROGRAM
...
4a

FIG. 4

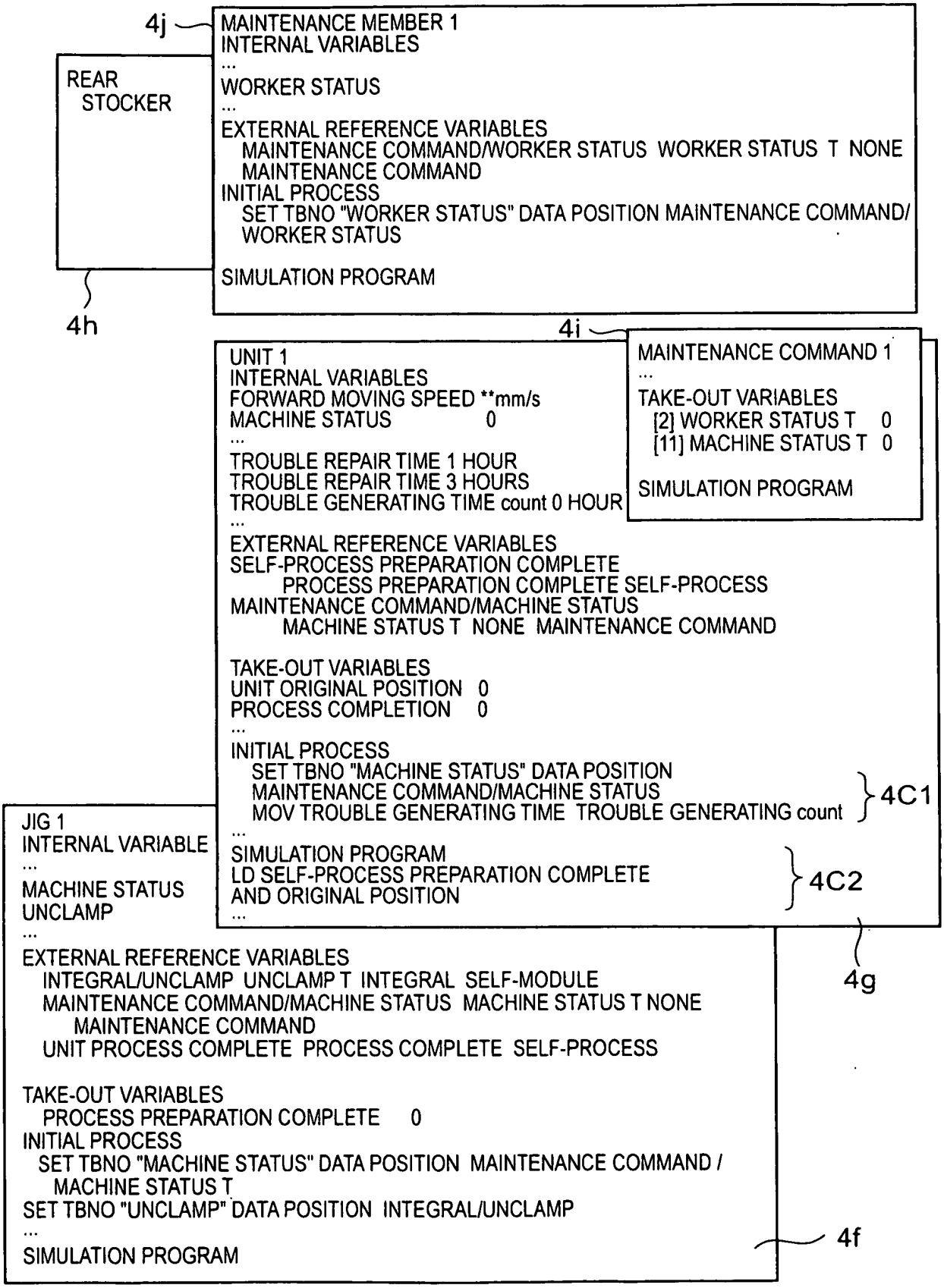
4j
MAINTENANCE MEMBER 1
INTERNAL VARIABLES
...
WORKER STATUS
...
EXTERNAL REFERENCE VARIABLES
MAINTENANCE COMMAND/WORKER STATUS WORKER STATUS T NONE
MAINTENANCE COMMAND
INITIAL PROCESS
SET TBNO "WORKER STATUS" DATA POSITION MAINTENANCE COMMAND/
WORKER STATUS
SIMULATION PROGRAM
REAR
STOCKER
4h
4i
MAINTENANCE COMMAND 1
...
TAKE-OUT VARIABLES
[2] WORKER STATUS T 0
[11] MACHINE STATUS T 0
SIMULATION PROGRAM
UNIT 1
INTERNAL VARIABLES
FORWARD MOVING SPEED **mm/s
MACHINE STATUS 0
...
TROUBLE REPAIR TIME 1 HOUR
TROUBLE REPAIR TIME 3 HOURS
TROUBLE GENERATING TIME count 0 HOUR
...
EXTERNAL REFERENCE VARIABLES
SELF-PROCESS PREPARATION COMPLETE
PROCESS PREPARATION COMPLETE SELF-PROCESS
MAINTENANCE COMMAND/MACHINE STATUS
MACHINE STATUS T NONE MAINTENANCE COMMAND
TAKE-OUT VARIABLES
UNIT ORIGINAL POSITION 0
PROCESS COMPLETION 0
...
INITIAL PROCESS
SET TBNO "MACHINE STATUS" DATA POSITION
MAINTENANCE COMMAND/MACHINE STATUS
MOV TROUBLE GENERATING TIME TROUBLE GENERATING count
4C1
...
SIMULATION PROGRAM
LD SELF-PROCESS PREPARATION COMPLETE
AND ORIGINAL POSITION
4C2
...
4g
JIG 1
INTERNAL VARIABLE
...
MACHINE STATUS
UNCLAMP
...
EXTERNAL REFERENCE VARIABLES
INTEGRAL/UNCLAMP UNCLAMP T INTEGRAL SELF-MODULE
MAINTENANCE COMMAND/MACHINE STATUS MACHINE STATUS T NONE
MAINTENANCE COMMAND
UNIT PROCESS COMPLETE PROCESS COMPLETE SELF-PROCESS
TAKE-OUT VARIABLES
PROCESS PREPARATION COMPLETE 0
INITIAL PROCESS
SET TBNO "MACHINE STATUS" DATA POSITION MAINTENANCE COMMAND /
MACHINE STATUS T
SET TBNO "UNCLAMP" DATA POSITION INTEGRAL/UNCLAMP
...
SIMULATION PROGRAM
4f

FIG. 5

DESCRIPTION OF SIMULATION PROGRAM

C1	LD	SELF-PROCESS PREPARATION COMPLETE
	AND	ORIGINAL POSITION
	ANDNOT	IN TROUBLE
	ANDNOT	PROCESS COMPLETE
	OUT	FORWARD MOVING COMMAND
C2	LD	FORWARD MOVING COMMAND
	MOTION	FORWARD MOVING OPERATION
C3	LD	FORWARD MOVING EDGE
	TMR	FORWARD MOVING EDGE TIMER FORWARD MOVING EDGE TIMER SETTING
C4	LD	FORWARD MOVING EDGE TIMER
	SET	PROCESS COMPLETE
C5	LD	PROCESS COMPLETE
	ANDNOT	ORIGINAL POSITION
	OUT	BACKWARD MOVING COMMAND
C6	LD	BACKWARD MOVING COMMAND
	MOTION	BACKWARD MOVING OPERATION
C7	LD	TROUBLE GENERATING TIME count > 0
	ANDF	TROUBLE GENERATION EXECUTION > 0
	SUB	TROUBLE GENERATING TIME count SCAN PITCH
		TROUBLE GENERATING TIME count
C8	LD	TROUBLE GENERATING TIME count <= 0
	ANDF	MACHINE STATUS = 0
	MOV	1 MACHINE STATUS

LADDER DISPLAY

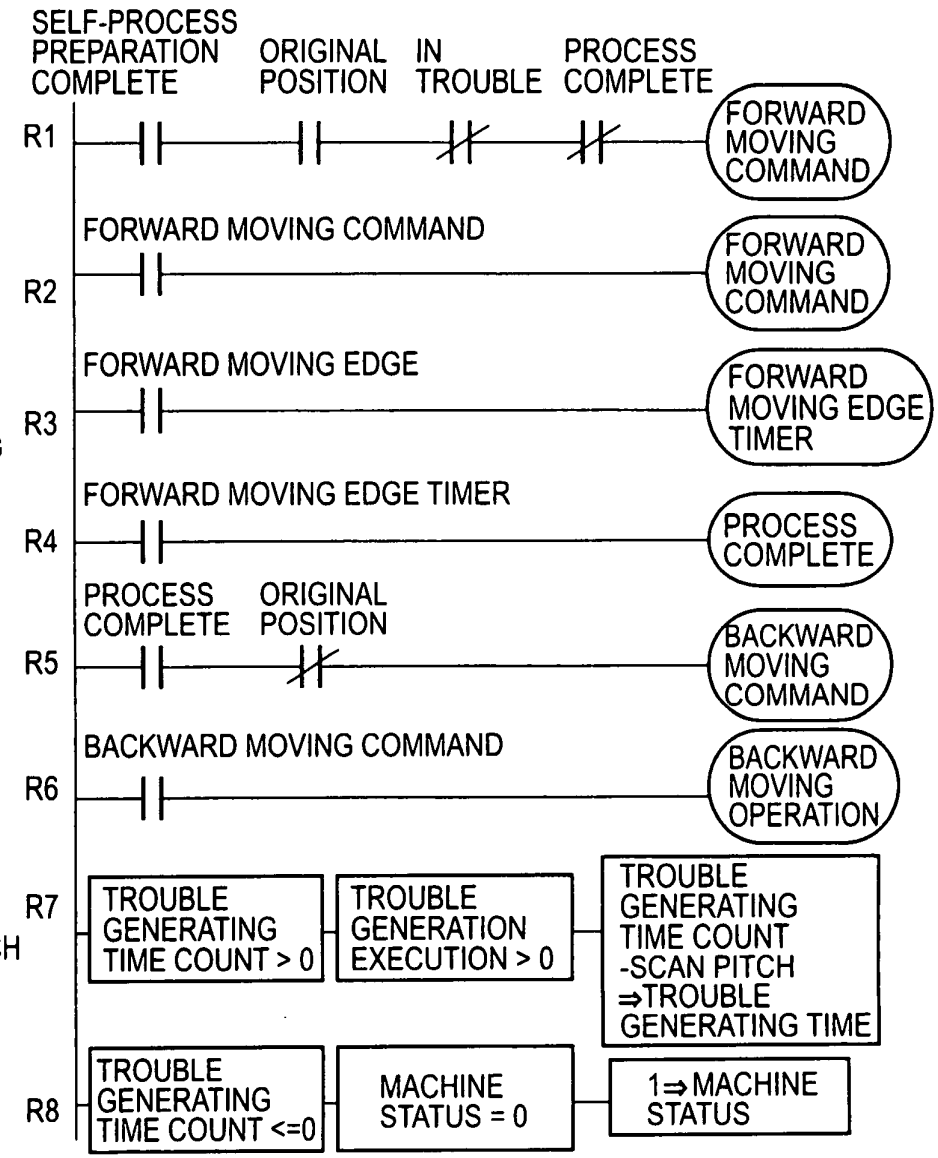

FIG. 6

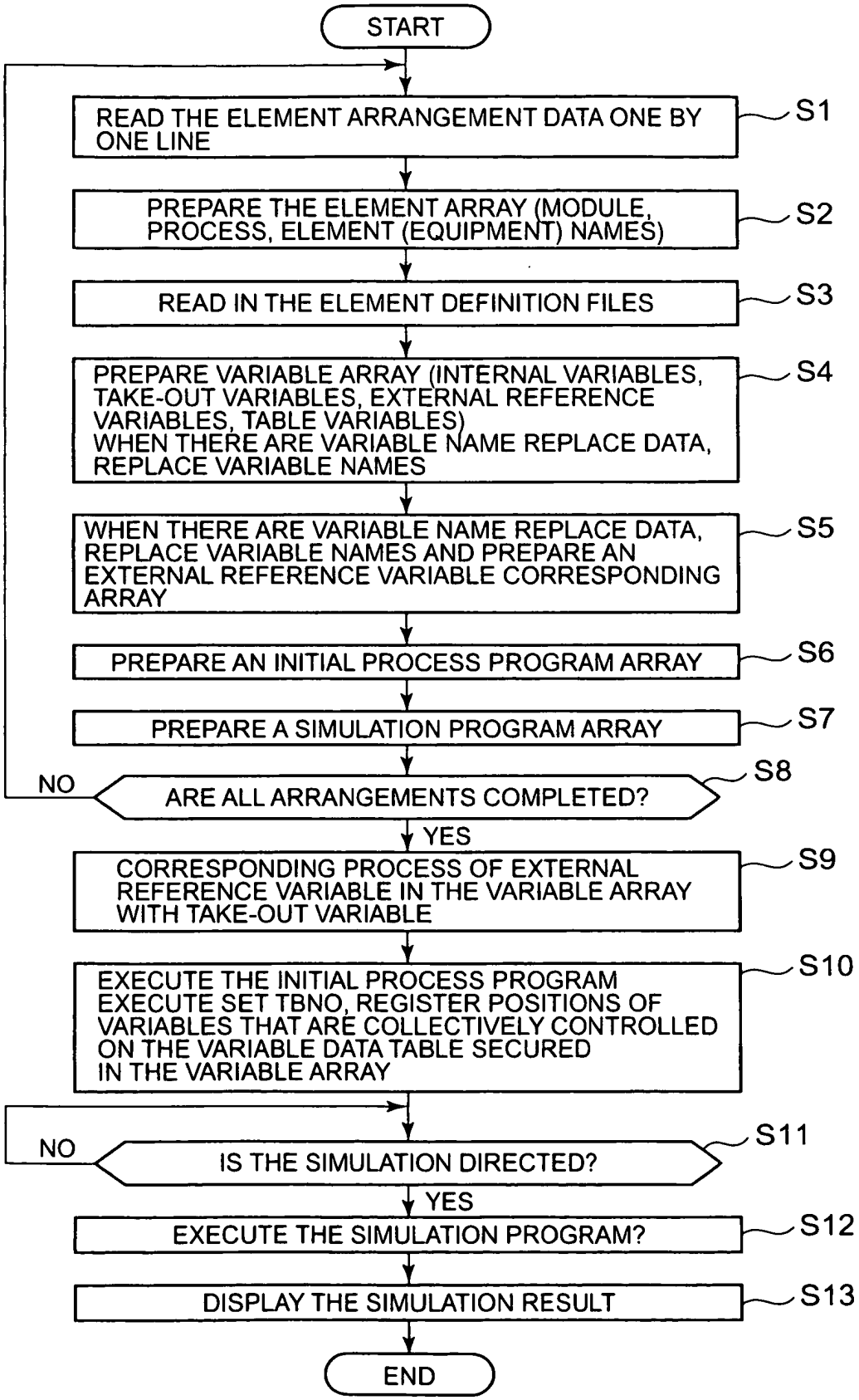
START
READ THE ELEMENT ARRANGEMENT DATA ONE BY ONE LINE
S1
PREPARE THE ELEMENT ARRAY (MODULE, PROCESS, ELEMENT (EQUIPMENT) NAMES)
S2
READ IN THE ELEMENT DEFINITION FILES
S3
PREPARE VARIABLE ARRAY (INTERNAL VARIABLES, TAKE-OUT VARIABLES, EXTERNAL REFERENCE VARIABLES, TABLE VARIABLES)
WHEN THERE ARE VARIABLE NAME REPLACE DATA, REPLACE VARIABLE NAMES
S4
WHEN THERE ARE VARIABLE NAME REPLACE DATA, REPLACE VARIABLE NAMES AND PREPARE AN EXTERNAL REFERENCE VARIABLE CORRESPONDING ARRAY
S5
PREPARE AN INITIAL PROCESS PROGRAM ARRAY
S6
PREPARE A SIMULATION PROGRAM ARRAY
S7
NO
ARE ALL ARRANGEMENTS COMPLETED?
S8
YES
CORRESPONDING PROCESS OF EXTERNAL REFERENCE VARIABLE IN THE VARIABLE ARRAY WITH TAKE-OUT VARIABLE
S9
EXECUTE THE INITIAL PROCESS PROGRAM EXECUTE SET TBNO, REGISTER POSITIONS OF VARIABLES THAT ARE COLLECTIVELY CONTROLLED ON THE VARIABLE DATA TABLE SECURED IN THE VARIABLE ARRAY
S10
NO
IS THE SIMULATION DIRECTED?
S11
YES
EXECUTE THE SIMULATION PROGRAM?
S12
DISPLAY THE SIMULATION RESULT
S13
END

FIG. 7

5 (ELEMENT ARRAY)

PROCESS IDENTIFICATION NAMES

POSITION IN ELEMENT ARRAY	MODULE NAME	PROCESS NAME	ELEMENT NAME	VARIABLE TOP POSITION	NUMBER
1	FRONT STOCKER		FRONT STOCKER	1	P0
2	140T	CONVEYOR	CONVEYOR	n1+1	P1
3	140T	CONNECTING TABLE	CONNECTING TABLE	n2+1	P2
4	140T	INTEGRAL	INTEGRAL 1	n3+1	...
5	140T	CONVEY	LF CONVEY	...	...
6	140T	1ST	JIG 1	...	...
7	140T	1ST	UNIT 1		
8	140T	2ST	JIG 1		
9	140T	2ST	UNIT 1		
10	140T	REAR CONNECTING TABLE	CONNECTING TABLE		
11	140T	CARRY-OUT CONVEYOR	CONVEYOR		
12	REAR STOCKER		REAR STOCKER		
13	MAINTENANCE COMMAND		MAINTENANCE COMMAND 1		
14	MAINTENANCE MEMBER A		MAINTENANCE MEMBER	...	...
15	MAINTENANCE MEMBER A		MAINTENANCE MEMBER	...	...

FIG. 8

6 (VARIABLE ARRAY)

VARIABLE POSITION (ADDRESS)	ATTRIBUTE	VARIABLE NAME	VALUE/ POSITION	
1	INTERNAL	d1	0mm	FRONT STOCKER
2	INTERNAL	d2	30mm	
Q1	INTERNAL	MACHINE STATUS	0	
		...		
		...		
n1+1		...		CONVEYOR (140T CONVEYOR)
R3	TAKE-OUT	a1	***	
		...		
n2+1		...		CONNECTING TABLE (140T CONNECTING TABLE)
	EXTERNAL REFERENCE	b1'	R4	
	EXTERNAL REFERENCE	a1"	R3	
		...		
n3+1				INTEGRAL 1 (140T INTEGRAL) UNCLAMP TABLE 20
L0	TAKE-OUT	UNCLAMP T[0]	2	
L0+1	TAKE-OUT	UNCLAMP T[1]	f5	
L0+2	TAKE-OUT	UNCLAMP T[2]	...	
n4+1		...		LF CONVEY (140T CONVEY)
R4	TAKE-OUT	b1	**	
		...		
		...		
n5+1	INTERNAL	...		JIG (140T1ST)
Q5	INTERNAL	MACHINE STATUS	0	
f5	INTERNAL	UNCLAMP	0	
...	EXTERNAL REFERENCE	INTEGRAL / UNCLAMP	L0+1	
...	EXTERNAL REFERENCE	MAINTENANCE COMMAND/MACHINE STATUS	T0+5	
...	EXTERNAL REFERENCE	UNIT PROCESS COMPLETE	R7	
R5	TAKE-OUT	PROCESS PREPARATION COMPLETE	0	
		...		
n6+1	INTERNAL	FORWARD MOVING SPEED	*mm/s	UNIT (140T1ST)
Q6	INTERNAL	MACHINE STATUS	0	
		...		
	INTERNAL	TROUBLE GENERATING TIME	1HOUR	
	INTERNAL	TROUBLE REPAIR TIME	3HOUR	
	INTERNAL	TROUBLE GENERATING TIME count	0HOUR	
	INTERNAL	TROUBLE GENERATION EXECUTION	1(YES)	
		...		
	TAKE-OUT	UNIT ORIGINAL POSITION	**	

(CONTINUED ON THE FOLLOWING PAGE)

FIG. 9

(CONTINUED FROM THE PREVIOUS PAGE)

6 (VARIABLE ARRAY)

VARIABLE POSITION (ADDRESS)	ATTRIBUTE	VARIABLE NAME	VALUE/ POSITION	
R7	TAKE-OUT	PROCESS COMPLETE	0	UNIT 1 (CONTINUED)
		...		
R6	EXTERNAL REFERENCE	SELF-PROCESS PREPARATION COMPLETE	R5	
t6	EXTERNAL REFERENCE	MAINTENANCE COMMAND/MACHINE STATUS	T0+6	
		...		
		...		JIG 1 (140T2ST)
		...		UNIT 1 (140T2ST)
				CONNECTING TABLE: 140T REAR CONNECTING TABLE
				CONVEYOR (140T CARRY-OUT CONVEYOR)
				REAR STOCKER (REAR STOCKER)
				20
T0	TAKE-OUT	MACHINE STATUS	11	MACHINE STATUS T TABLE
L0+1	TAKE-OUT	MACHINE STATUS T[1]	Q1	
L0+2	TAKE-OUT	MACHINE STATUS T[2]	Q2	
...	TAKE-OUT	...		
T0+11	TAKE-OUT	MACHINE STATUS T[11]	Q11	MAINTENANCE COMMAND 1 (MAINTENANCE COMMAND)
"WORKER STATUS T" TABLE				20
		...		MAINTENANCE MEMBER (MAINTENANCE MEMBER A)
		...		MAINTENANCE MEMBER (MAINTENANCE MEMBER B)

FIG. 10

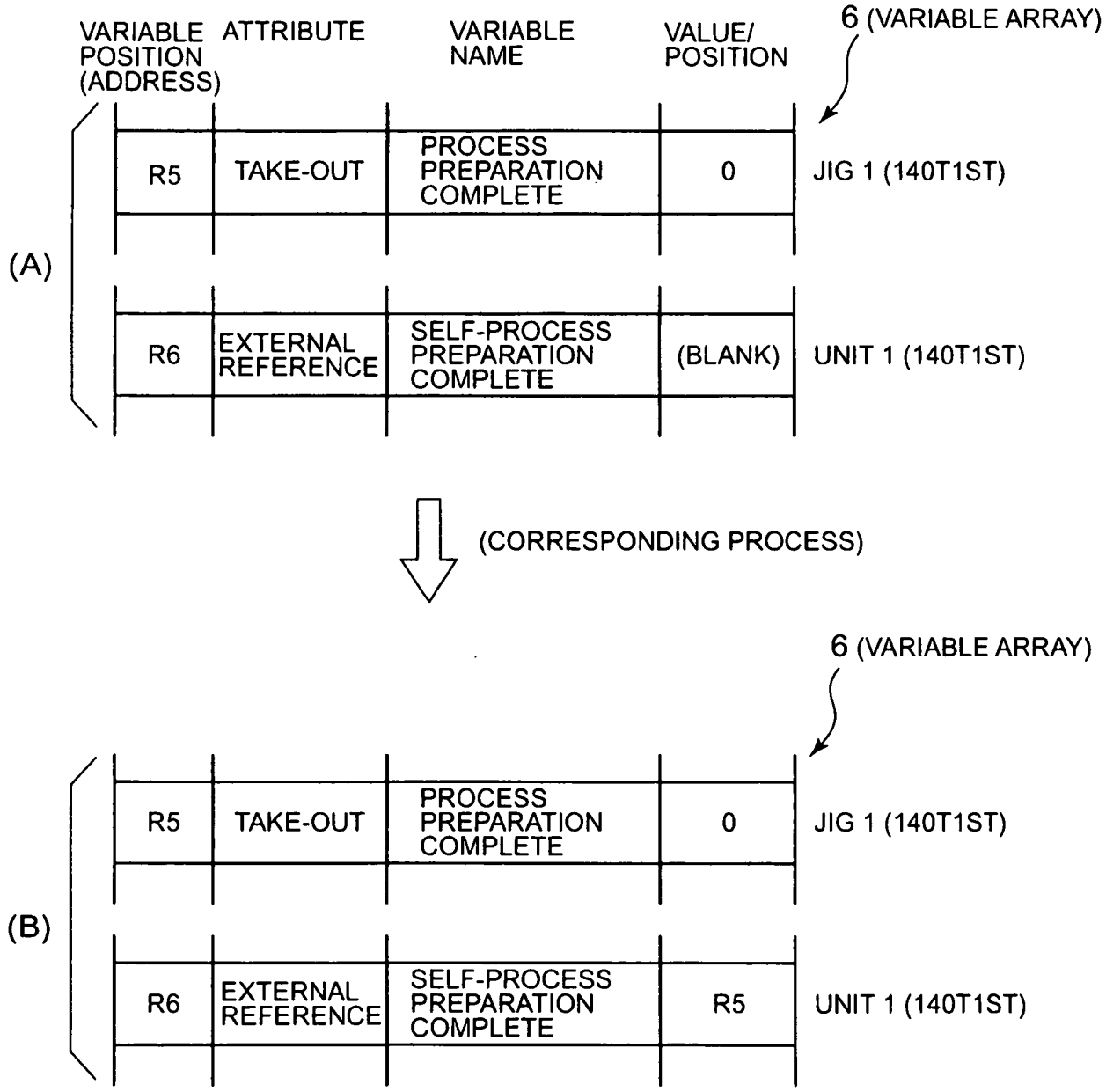
6 (VARIABLE ARRAY)
VARIABLE POSITION (ADDRESS)
ATTRIBUTE
VARIABLE NAME
VALUE/ POSITION
(A)
R5
TAKE-OUT
PROCESS PREPARATION COMPLETE
0
JIG 1 (140T1ST)
R6
EXTERNAL REFERENCE
SELF-PROCESS PREPARATION COMPLETE
(BLANK)
UNIT 1 (140T1ST)
(CORRESPONDING PROCESS)
6 (VARIABLE ARRAY)
(B)
R5
TAKE-OUT
PROCESS PREPARATION COMPLETE
0
JIG 1 (140T1ST)
R6
EXTERNAL REFERENCE
SELF-PROCESS PREPARATION COMPLETE
R5
UNIT 1 (140T1ST)

FIG. 11

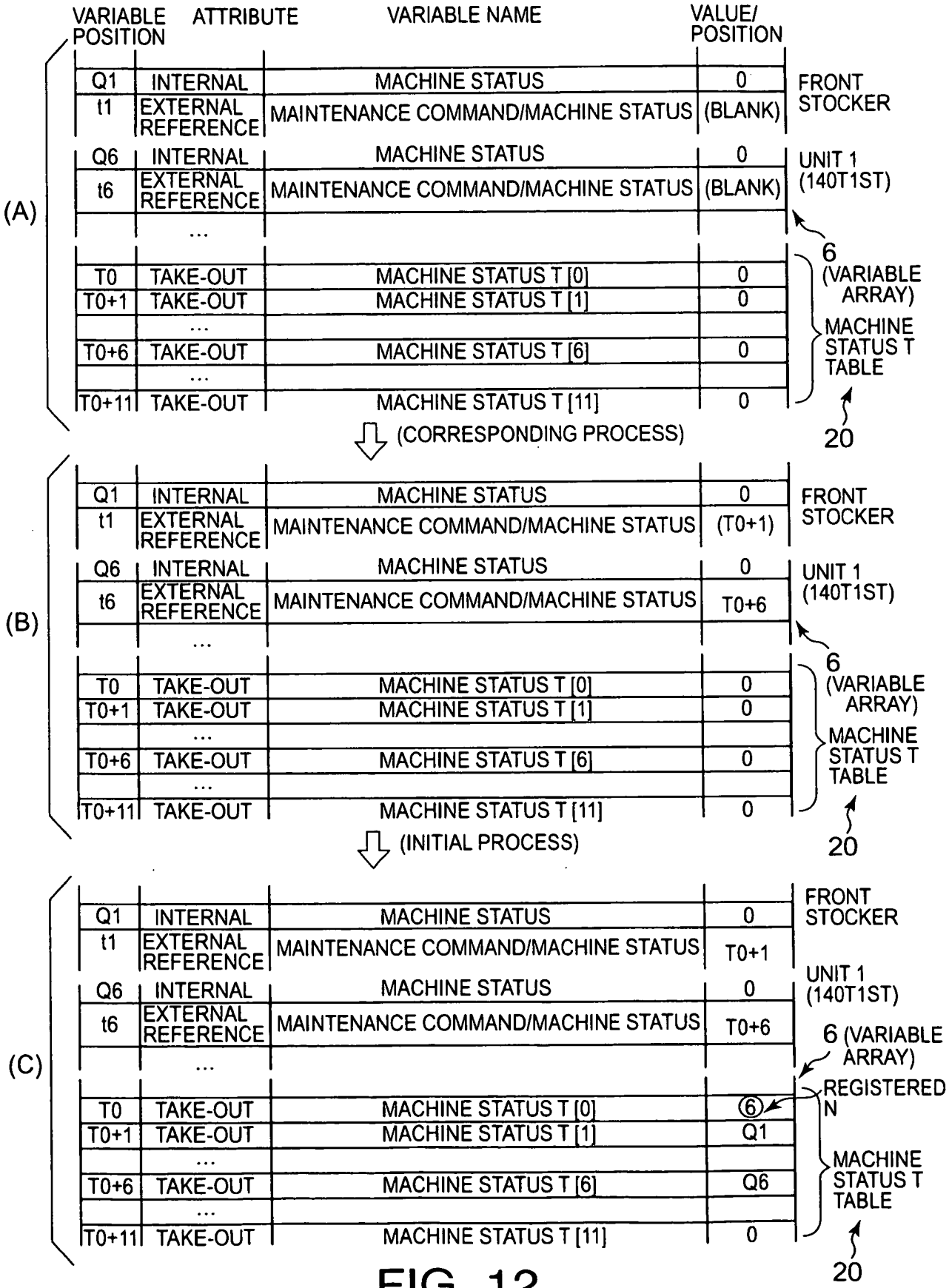
VARIABLE POSITION
ATTRIBUTE
VARIABLE NAME
VALUE/ POSITION
(A)
Q1 INTERNAL MACHINE STATUS 0
t1 EXTERNAL REFERENCE MAINTENANCE COMMAND/MACHINE STATUS (BLANK)
FRONT STOCKER
Q6 INTERNAL MACHINE STATUS 0
t6 EXTERNAL REFERENCE MAINTENANCE COMMAND/MACHINE STATUS (BLANK)
UNIT 1 (140T1ST)
...
T0 TAKE-OUT MACHINE STATUS T [0] 0
T0+1 TAKE-OUT MACHINE STATUS T [1] 0
T0+6 TAKE-OUT MACHINE STATUS T [6] 0
T0+11 TAKE-OUT MACHINE STATUS T [11] 0
6 (VARIABLE ARRAY)
MACHINE STATUS T TABLE
20
(CORRESPONDING PROCESS)
(B)
Q1 INTERNAL MACHINE STATUS 0
t1 EXTERNAL REFERENCE MAINTENANCE COMMAND/MACHINE STATUS (T0+1)
FRONT STOCKER
Q6 INTERNAL MACHINE STATUS 0
t6 EXTERNAL REFERENCE MAINTENANCE COMMAND/MACHINE STATUS T0+6
UNIT 1 (140T1ST)
T0 TAKE-OUT MACHINE STATUS T [0] 0
T0+1 TAKE-OUT MACHINE STATUS T [1] 0
T0+6 TAKE-OUT MACHINE STATUS T [6] 0
T0+11 TAKE-OUT MACHINE STATUS T [11] 0
6 (VARIABLE ARRAY)
MACHINE STATUS T TABLE
20
(INITIAL PROCESS)
(C)
Q1 INTERNAL MACHINE STATUS 0
t1 EXTERNAL REFERENCE MAINTENANCE COMMAND/MACHINE STATUS T0+1
FRONT STOCKER
Q6 INTERNAL MACHINE STATUS 0
t6 EXTERNAL REFERENCE MAINTENANCE COMMAND/MACHINE STATUS T0+6
UNIT 1 (140T1ST)
6 (VARIABLE ARRAY)
T0 TAKE-OUT MACHINE STATUS T [0] ⑥
T0+1 TAKE-OUT MACHINE STATUS T [1] Q1
T0+6 TAKE-OUT MACHINE STATUS T [6] Q6
T0+11 TAKE-OUT MACHINE STATUS T [11] 0
REGISTERED N
MACHINE STATUS T TABLE
20

FIG. 12

7 (EXTERNAL REFERENCE VARIABLE CORRESPONDING ARRAY)

POSITION IN ELEMENT ARRAY	EXTERNAL REFERENCE VARIABLE NAME	REFERRING VARIABLE NAME	REFERRING MODULE NAME PROCESS NAME
3	b1'	b1	140T CONVEY
3	a1"	a1	140T CONVEYOR
...			
...			
3	SELF-PROCESS PREP-ARATION COMPLETE	PROCESS PREP-ARATION COMPLETE	1401ST
...			

FIG. 13

8 (INITIAL PROCESS PROGRAM ARRAY)

FRONT STOCKER
CONVEYOR
CONNECTING TABLE
INTEGRAL 1
LF CONVEY
JIG 1
UNIT 1
JIG 1
UNIT 1
CONNECTING TABLE
CONVEYOR
REAR STOCKER
MAINTENANCE COMMAND
MAINTENANCE MEMBER
MAINTENANCE MEMBER

FIG. 14

9 (SIMULATION PROGRAM ARRAY)

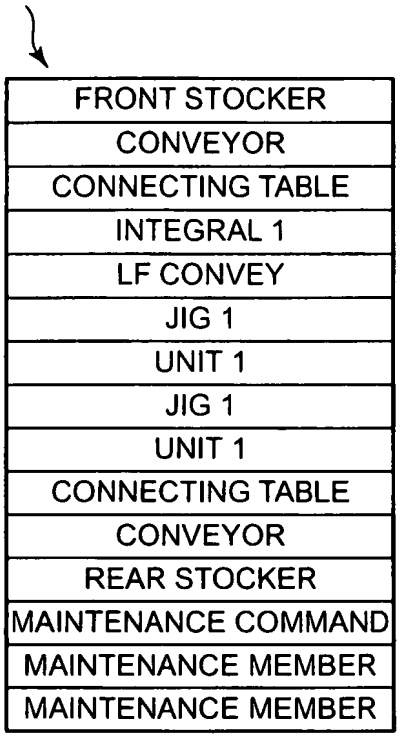

FIG. 15

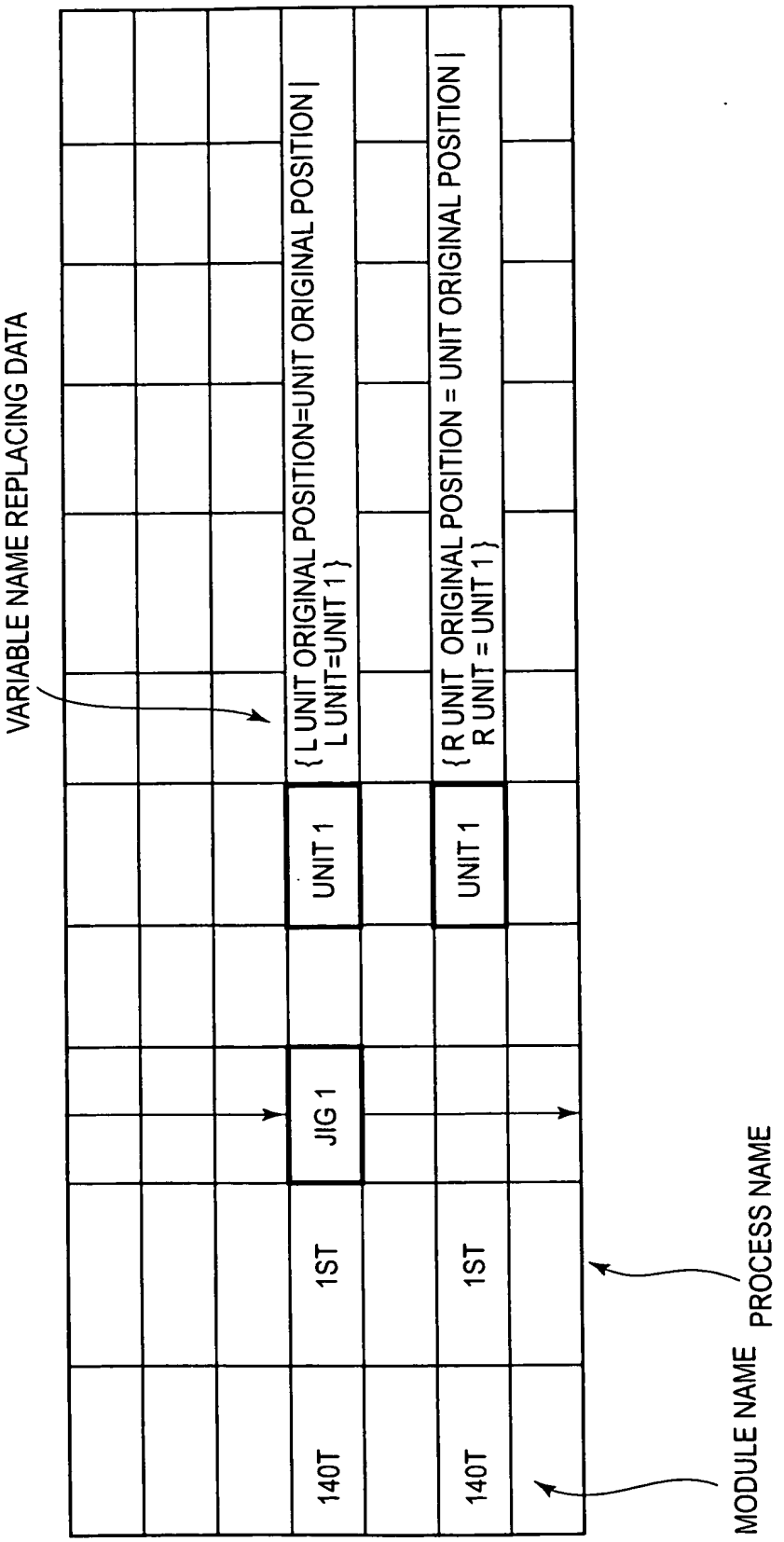
VARIABLE NAME REPLACING DATA
{ L UNIT ORIGINAL POSITION=UNIT ORIGINAL POSITION |
L UNIT=UNIT 1 }
{ R UNIT ORIGINAL POSITION = UNIT ORIGINAL POSITION |
R UNIT = UNIT 1 }
UNIT 1
UNIT 1
JIG 1
1ST
1ST
140T
140T
PROCESS NAME
MODULE NAME

FIG. 16

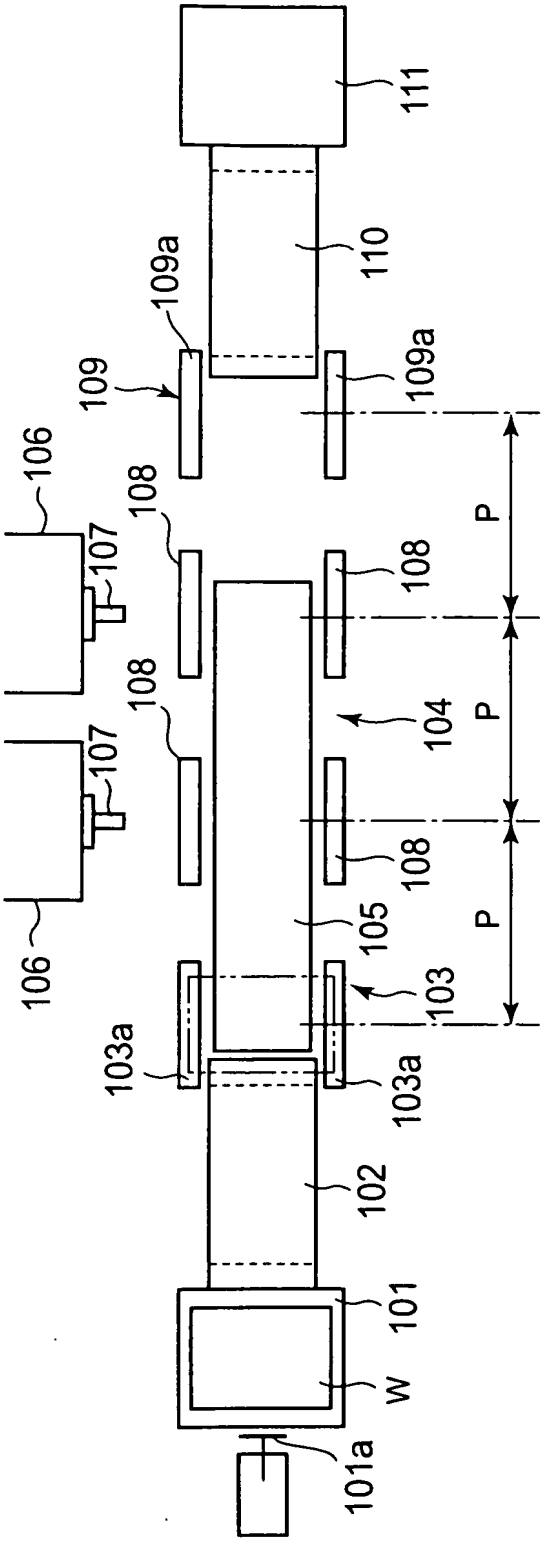

FIG. 17A

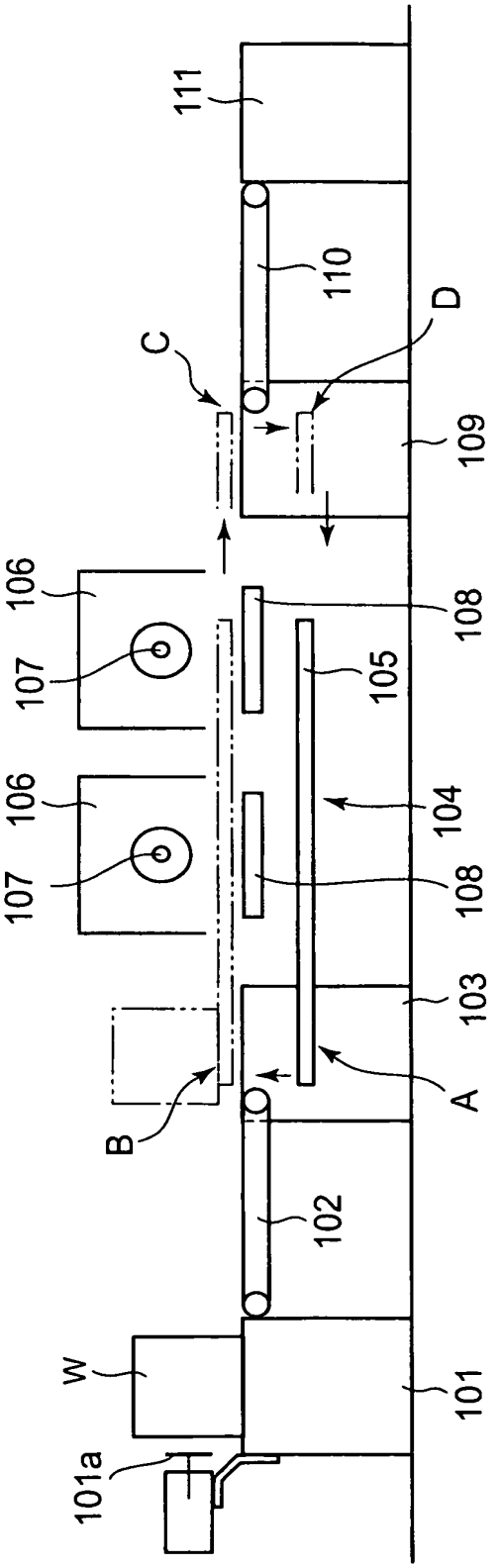

FIG. 17B